Closure to "An experimental study on fish-friendly trashracks: part I & II" by S. RAYNAL, L. CHATELLIER, D. COURRET, M. LARINIER and L. DAVID, *J. Hydraulic Res.* 51(1), 2013, 56–75

SYLVAIN RAYNAL, LUDOVIC CHATELLIER, DOMINIQUE COURRET, MICHEL LARINIER and LAURENT DAVID

The Authors thank the Discussers for their observations on our two papers. Four main points, related to head-loss predictions for angled trashracks, have been underlined by the Discussers and are discussed here.

First, the Discussers compared various angled trashrack configurations and emphasized the necessity for more detailed information in the head-loss formulas. The Authors acknowledge that their experiments only comprised configurations where the slat angle β was the complementary of the rack angle α, and that Eq. (7) is therefore primarily intended for such racks. The Authors also agree, as stated in their papers, that differences with the previous studies may be due to the differences in flume configurations. However, it is necessary to stress that the new head-loss equations provided in Raynal *et al.* (2013a, 2013b) are focusing on fish-friendly trashracks that generate tangential currents. As a consequence, perpendicular racks with rotating bars (Fig. D1c) were not considered.

The Authors would also like to comment on the Discussers' remark concerning the 30–60% difference between Raynal *et al.* (2013b) measurements and Meusburger's formula (Eq. 2). Meusburger's equation produces rather good predictions with rectangular bars (*PR*) and deviations from Raynal *et al.* (2013b) measurements are always less than 30%. But for hydrodynamic bars (*PH*), these deviations may reach 60% because Meusburger (2002) experimentally investigated only rectangular bars assuming that the effect of the angle α is the same for all bar shapes. This is different from the Authors measurements, which reveal that the effect of the angulation is larger for *PH* bars than for *PR* bars ($k_{PH} > k_{PR}$). Therefore, the 30–60% difference is not only due to the channel configuration, as suggested by the Discussers, but also due to Meusburger's assumptions.

Apart from this, the Authors acknowledge that a generalized equation could be useful but the idea of the Discussers of separating the rack angle α from the slat angle β may not be sufficient to develop a fully generalized equation. The Discussers' Fig. D1a and D1b represents distinct configurations whereas they have the same angles α and β. Therefore, the angle δ, corresponding to the angle between the upstream and the downstream flumes, would also be required to differentiate these configurations. These three angles would be particularly necessary to describe Zimmermann (1969) experiments where $\alpha = 90°$, $\delta = 0°$ and where β varies. Thus, the Authors acknowledge that calling racks with $\alpha = 90°$ "angled trashracks" is not completely appropriate.

The second point addressed by the Discussers is the idea of separating the effects of the different elements composing the trashrack. They quote the study of Raynal *et al.* (2013a) on inclined racks and that of Alsaffar (1974) on angled fish protective screens where this separation is made. In the Authors' experiments, the ratio e/b between bar spacing and bar thickness is lower than or equal to 3. In such configurations, when the rack is not inclined, the head-loss is mainly due to the bars. This is the reason why the head-loss for perpendicular and vertical racks may be calculated using a function of O_g, where the blockage effect of spacers is included, but using a form coefficient only related to the bar shape, since bars are the most influential parameter. This is particularly true with angled racks, for which the main part of the head-loss is due to the redirection of the flow by the angled bars. Therefore, the Authors think that differentiating elements, like bars and spacers for example, in head-loss equations for perpendicular or angled racks would not provide significant improvements. Though, one angled configuration where this kind of separation might be useful could be angled trashracks with horizontal bars. In such configurations, the effect of bars can be similar to that of vertical bars in inclined configurations, and separating the bar effect from that of the supporting vertical elements might be necessary.

The third discussed point concerns a comparison of experimental data from the Discussers with an experimental value of Raynal *et al.* (2013b) for a rack angled at $\alpha = 45°$ with slats angled at $\beta = 45°$. The geometrical differences between these two configurations are the bar spacing, the number of spacers and the slat length. As explained before, the spacers produce far less head-loss than bars in angled configurations. Moreover, as shown in Fig. 2 (Raynal *et al.* 2013b), the effect of the bar spacing is rather low at $\alpha = 45°$. Indeed, for *PH* and *PR* bars spaced by 10 and 15 mm, head-loss coefficients are similar. Furthermore, concerning the slat length effect, Zimmermann (1969) includes it in its equation and the Authors have also carried out some additional measurements that reveal the influence of the parameter p. For example, at $\alpha = 45°$, with $e = 10$ mm and $b = 5$ mm, measurements result in $\xi(p/b = 8) = 3.29$ and $\xi(p/b = 12) = 3.80$. Therefore, it is not surprising that the slight geometrical differences in the trashrack configuration do not result in large head-loss differences in Fig. D2. However, unlike the Discussers, the Authors think that the slight difference is mainly due to the measurement uncertainties and slat lengths.

The Discussers finally focus on the effect of the ratio H/b on the head-losses. The Authors are not convinced by Figs. D2 and D3 and think that more details are required for a proper discussion. E.g. it is not clear whether the rack is angled in Fig. D3. It seems quite surprising for the Authors that differences between transverse water levels are always lower than 1 mm. This might be explained if upstream velocities are really low but this is totally different from the Authors' observations during experiments for which downstream water levels varied a lot from one side to the other. The Authors also wonder how the head-loss due to the channel and the measurements uncertainties are taken into account in Fig. D3.

Furthermore, concerning Fig. D2, as stated by the Discussers, R_b is higher than 2750 meaning that V_1 is higher than 0.55 m s^{-1}. Therefore, since they obtained ξ values around 3.4, they should have measured a downstream water level 52 mm lower than the upstream one. In the meantime, their upstream water level at $H/b = 10$ should be 50 mm only. Therefore, some additional details are needed to clarify this matter.

To conclude, the Authors thank the Discussers for their observations. Their comparison of various angled trashracks highlighted some salient parameters necessary for a generalized equation. However, the Authors do not fully agree with the proposition of separating the effects of spacers and bars in angled trashracks and think that the clarification of the effect of H/b need further investigations.

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